Before the

Federal Communications Commission

Washington, D.C. 20554

In the Matter of	)	
	)	
Allocation and Designation of Spectrum for	)	IB Docket No. 97-95
Fixed-Satellite Services in the 37.5-38.5 GHz,	)	
40.5-41.5 GHz and 48.2-50.2 GHz Frequency	)	RM-8811
Bands; Allocation of Spectrum to Upgrade Fixed	)	
and Mobile Allocations in the	)	
40.5-42.5 GHz Frequency Band; Allocation of	)	
Spectrum in the 46.9-47.0 GHz Frequency Band	)	
for Wireless Services; and Allocation of Spectrum	)	
in the 37.0-38.0 GHz and	)	
40.0-40.5 GHz for Government Operations	)	

To: The Commission

COMMENTS OF
WINSTAR COMMUNICATIONS, INC.

Pursuant to Section 1.415 of the rules of the Federal Communications Commission ("FCC" or "Commission"), Winstar Communications, Inc. ("Winstar") hereby submits these comments in the above-captioned proceeding.[1]

BACKGROUND

Winstar is a national facilities-based broadband services company offering local and long distance telecommunications, high-speed Internet, and data services. It provides these services through a variety of technologies, including its fixed wireless systems that operate pursuant to exclusive, area-wide licenses in the 38.6-40.0 GHz band (the "37.5-40.0 and

42.0-42.537.5-40.0 and 42.0-42.537.5-40.0 and 42.0-42.5 GHz band") and 16 similar licenses in the Local Multipoint Distribution Service or "LMDS" (27.5-29.5 GHz and 31 GHz) bands. Winstar also holds spectrum in a number of other point-to-point Part 101 bands, including the 6 GHz, 10 GHz and 18 GHz bands.

Winstar supports the FCC proposal to modify the band plan for the 36.0-51.4 GHz band to reflect decisions reached at the 2000 World Radiocommunication Conference ("WRC-2000") in Istanbul, Turkey, which provides satellite and terrestrial operators with greater certainty about their scope of operations in this band. In particular, Winstar supports the proposed specific power flux-density ("PFD") limits on satellite operations in portions of this band consistent with the results of WRC-2000 as they will maximize efficient use of the radio frequency spectrum by both satellite and terrestrial users with minimal changes to the existing Table of Frequency Allocations

Winstar strongly supports the Commission's efforts to create a band plan for the 36.0-51.4 GHz band and otherwise modify its rules to achieve optimal usage of that spectrum by fixed wireless and satellite providers. Subject to certain minor adjustments proposed herein, the proposals set forth in the *FNPRM* will give fixed wireless and satellite providers greater operational certainty *without* reducing the amount of amount of spectrum currently available to them. As such, the *FNPRM* represents a sound and workable solution, that will minimize sharing burdens and facilitate more rapid deployment fixed wireless services, to the ultimate benefit of consumers.

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[1] *Further Notice of Proposed Rulemaking*, IB Docket No. 97-95, FCC 01-182 (rel. May 31, 2001) ("FNPRM").

Winstar believes that the Commission's actions in this proceeding must be guided by the principles set forth at footnote 65 of the *FNPRM*:

> [I]n the United States and in some other parts of the world, the primary FS application below 40 GHz is ubiquitous terrestrial broadband services. These FS operators intend to compete with wireline and fiber-optic services. To compete successfully against these services, FS providers must assure their customers very high availability and quality. To ensure high availability and quality, FS operations require more protection from potential interference than some other services with lower availability and quality requirements. If FS providers cannot provide adequate availability and quality, FS will fail to compete effectively with wireline and fiber-optic services.

In the below discussion section, Winstar provides responses to specific questions raised by the Commission in the FNPRM.

DISCUSSION

1. ***FCC PROPOSAL.* REDESIGNATE PORTIONS OF SATELLITE AND WIRELESS SERVICES SPECTRUM; PROPOSAL TO TAKE THE WRC-2000 SHARING ARRANGEMENT INTO ACCOUNT IN MANAGING THE DOMESTIC BAND PLAN; PROPOSAL TO RE-DESIGNATE THE 37.6-38.6 GHz BAND FOR WIRELESS SERVICES AND THE 41.0-42.0 GHz BAND FOR SATELLITE SERVICES.**[2]

Winstar supports this re-designation proposal, keeping in mind the intent of the FCC to permit limited (constrained operations) of terrestrial wireless services in the satellite designated band(s), and satellite gateway operations in the terrestrial wireless services band.

***2. FCC PROPOSAL.* SHIFT THE MSS (MOBILE SATELLITE SERVICE) ALLOCATION FROM THE 39.5-40.0 GHZ BAND TO THE 40.5-41.0 GHz BAND TO REFLECT THE RESULTS OF WRC-2000 IN THE DOMESTIC BAND PLAN.**[3]

[2] FNPRM at para. 15.
[3] FNPRM at para. 13, 22-23.

Winstar supports the MSS allocation proposal, as it reflects the spirit of the carefully constructed "soft segmentation" position that the United States brought into WRC-2000 to the extent that it will avoid potentially intractable interference problems to the both the FS and MSS.

3. <u>FC PROPORSAL.</u> MODIFY PART 25 AND PART 101 RULES TO REFLECT NEW DESIGNATIONS.[4]

Winstar supports the Commission proposal with the understanding that these changes will materially afford the intended flexibility for HDFS operations in the 37.5-40.0 and 40.0-42 GHz bands, as reflected in the "designation" or "re-designation" of those bands as available for wireless services.

4. <u>FCC PROPOSAL</u>. SHIFT MSS ALLOCATION FROM 39.5-40.0 GHZ TO 40.5-41.0 GHz; ADD A PRIMARY GOVERNMENT MSS (NTIA HAS COMMITTED TO OBSERVE THE PROVISIONAL PFD LIMITS ON MSS THAT WRC-2000 ADOPTED AND PROHIBIT GOVERNMENT MSS EARTH STATIONS IN THE 37.5-40.0 GHZ AND 42.0-42.5 GHZ FROM CLAIMING PROTECTION FROM NON-GOVERNMENT STATIONS OPERATING IN THE FIXED AND MOBILE SERVICES, CONDITIONED ON MILITARY ACCESS TO THE 40.5-41.0 GHz BAND FOR PRIMARY FSS AND MSS OPERATIONS – HATCH LETTER OF 03/02/01) AND A PRIMARY OR SECONDARY NON-GOVERNMENT MSS ALLOCATION IN THE 40.5-41.0 GHz BAND (CONSEQUENCES OF ADOPTING A PRIMARY MSS ALLOCATION WHEN THE INTERNATIONAL TABLE FOR REGION 2 PROVIDES FOR ONLY A SECONDARY ALLOCATION).[5]

Winstar supports the FCC proposal

[4] FNPRM at para. 17.
[5] FNPRM at para. 23.

5. ***<u>FCC PROPOSAL.</u>* ADD A PRIMARY FSS ALLOCATION TO THE 41.0-42.0 GHz BAND; RE-DESIGNATE THE SPECTRUM AVAILABLE FOR WIRELESS SERVICES FROM 41.0-42.0 GHz TO 37.6-38.6 GHz AND RE-DESIGNATE THE SPECTRUM AVAILABLE FOR SATELLITE USE FROM 37.6-38.6 GHz TO 41.0-42.0 GHz.**

Winstar supports the FNPRM proposal

6. ***<u>FCC PROPOSAL.</u>* FSS PFD LIMITS (FCC STRONGLY INCLINED TO CONCLUDE THAT THE BENEFITS OF ADOPTING PFD LIMITS FOR THIS BAND NOW SUBSTANTIALLY OUTWEIGH ANY POTENTIAL ADVANTAGE IN AWAITING THE FINAL RESULTS OF WRC-2003; COMMENTERS WHO PROPOSE THAT FCC DELAY IN BRINGING THESE BENEFITS TO THE PUBLIC SHOULD EXPLAIN WITH PARTICULARITY HOW ADDITIONAL DELAY WOULD PROMOTE THE PUBLIC INTEREST).**

The Commission, the U.S. State Department and the NTIA have all worked very hard within the CITEL and WRC-2000 communities to gain acceptance of the "soft-segmentation" proposal. One of the key ingredients of that proposal is the pfd mask applicable to GSO FSS and NGSO FSS satellites. The S21.4 minus 12 dB mask was accepted at the WRC-2000 Conference, on a provisional basis, for Region 2. Immediate domestic implementation of the proposals that are contained in the FNPRM is required. Any delay will simply encourage and embolden Europe to try to impose their vision of V-band allocations and pfd masks on the U.S. There are significant FS implementations in the 38.6-40.0 GHz band. The 39 GHz auction concluded last year and the licenses for terrestrial operation have been awarded to the highest bidders. Any delay in adopting the FSS pfd masks will unnecessarily create uncertainties in the marketplace that broadband wireless industry cannot further endure.

Winstar has attached (Attachment-1) excerpts from the May 15, 2001, NSMA (National Spectrum Managers Association) Newsletter. The excerpts provide a detailed discussion of FS deployment characteristics and the rationale for adopting the FSS pfd mask of S21.4 minus 12 dB. The information contained in the excerpts is identical to the information put forward by the U.S. Delegation at the WRC-2000 Conference.

7. <u>FCC PROPOSAL.</u> DEFAULT RULE FOR PFD LIMITS; WHETHER IT WOULD BE ADVISABLE OR MORE BENEFICIAL TO FOLLOW THE APPROACH ADOPTED BY WRC-2000 IN ARTICLE S21 OF THE FINAL ACTS (rather than the pre-2000 U.S./CITEL approach, which establishes lower pfd limits for normal operating conditions and, where applicable, allows licensees to increase power to compensate for fading conditions); <u>ACCOMPANYING FCC QUESTION.</u> WHAT, IF ANY, TECHNICAL OR PRACTICAL COMPLICATIONS MIGHT ARISE IF HIGHER PFD LIMITS FOR FADE CONDITIONS WERE ESTABLISHED AND SATELLITE OPERATORS WERE REQUIRED TO DECREASE POWER FOR NORMAL OPERATING CONDITIONS.

Permitting FSS to operate up to or at S21.4 pfd levels and then requiring them to reduce power by 12 dB during normal conditions, will create a situation of vagueness as to what constitutes “normal operating conditions”. This will place the burden on the HDFS operators to police the FSS operators (almost at all times) to make sure that the FSS is operating at required the lower pfd levels and also creates the untenable and unworkable dynamic by which satellite operators must cease or alter operations once they are in orbit. That cannot and never has worked. On the other hand, requiring the FSS to operate at S21.4 minus 12 dB levels, and then providing a manageable “vehicle” for being able to increase power up to S21.4 levels during fading conditions, will reasonably shift the burden to FSS operators to be diligent about when and how they can operate at higher power levels. Subject to ongoing interference studies, including those regarding uncorrelated fading conditions (see Attachment 2), setting FSS requirements at S21.4 minus 12 dB with a carefully defined vehicle for the limited increase in power will be the only situation.

Further, in accordance with the proposals in the Secondary Markets proceeding[6], and Winstar positions in that proceeding,[7] the FSS operators should be required to reach commercial agreements with licensees who acquired their spectrum in the satellite gateway beam area, and achieve appropriate coordination arrangements.

Winstar believes that the FCC is truly on the right track, and it is necessary to make certain that the technical and service rules that stipulate the operational pfd levels will need to carefully crafted so there is no room for "undoing" or "working around" the Commission's basic intent.

WHEREFORE, THE PREMISES CONSIDERED, Winstar Communications, Inc. requests that the Commission proceed expeditiously and adopt the technical and allocation related proposals, as outlined in the FNPRM, and giving due consideration to the comments and proposals made by Winstar in our comments, as above.

Respectfully submitted,

WINSTAR COMMUNICATIONS, INC.

/s/

Joseph M. Sandri, Jr.
Dr. Jay Ramasastry

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[6] WT Docket No. 00-230.

[7] Winstar Comments (filed Feb. 9, 2001), Reply Comments (filed Mar. 12, 2001), and ex parte (filed Mar. 13, 2001), in WT Docket No. 00-230 are all incorporated here by reference.

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Date: September 4, 2001

Attachment-1

Scientific Study from the May 15, 2001, National Spectrum Managers Associations ("NSMA") Newsletter Concerning FS Deployment Characteristics and Interference Protection Requirements in Satellite Environments

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Co-existence Requirements for Fixed Service Sytems in the 37.0 – 40.0 GHz Band

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Various segments of the 37.0 - 40.0 GHz band are allocated to the fixed service ("FS"), fixed satellite service ("FSS") and mobile satellite service ("MSS") on a co-primary basis. Segments of this band are being used or planned for high-density applications in the FS ("HDFS"). Co-frequency sharing is not feasible between HDFS and high density FSS systems, but sharing situations where only FS operates with ubiquitously-deployed small terminals may be practicable.

This document addresses the deployment characteristics of HDFS networks that provide, or plan to provide, Broadband Wireless Access ("BWA") applications in the 37.0 – 40.0 GHz band. The unique characteristics of some HDFS networks in this band, which include links across a very wide range of elevation angles, makes them much more sensitive to satellite downlink interference than more traditional FS networks or HDFS networks with smaller concentrations of high elevation angle links. Therefore, it is important to take into consideration these deployment characteristics to ensure the protection of FS systems from interference caused by FSS systems in the band 37.0 – 40.0 GHz.

I. BWA Networks Require 99.999% Availability.

BWA links normally compete with fiber optic based links, or act as "last mile" extensions of fiber optic links when fiber cannot be timely and economically extended. This requires BWA networks to have a minimum availability of 99.999% (5 x 9's). Similarly, performance requirements are very stringent, requiring BER levels of 10^{-12} or better.

II. BWA Networks Use a Mix of Point-to-Point ("P-P") and Point-to-Multipoint ("P-MP") Links.

In order for BWA networks to deliver sufficient bandwidth to buildings within metropolitan areas for small- to medium-sized businesses, it is necessary to deploy both P-P and P-MP systems. By using both types of systems (often overlaid on top of each other), BWA operators can keep their network architectures flexible enough to increase capacity where needed and conserve spectrum where possible.

For example, P-MP systems can be installed to provide initial coverage in previously unserved territories to ascertain where the traffic demand is. This might be 4 x 90 degree sectors initially, and could be expanded or overlaid with other sectors as necessary. Once a building, which may have multiple customers, exceeds a certain capacity requirement, the BWA operator would either add P-MP overlays or install a higher-capacity P-P link to that building instead. As this process continues, the mix of the BWA network moves increasingly toward P-P links. Once the services are primarily P-P links and/or when there is limited capacity and/or there is additional interference potential one can use the P-MP system to recover some deployed capacity that is not being utilized to the fullest. This is because the P-MP system enables more efficient spreading of smaller or more variable spectrum demand across the assigned spectrum.

Typically, P-P links are deployed when the customer capacity requirement is higher than about 10 Mbps. In some cases, P-P links are deployed where P-MP links are unable to offer the required performance. Currently, the P-P systems are up to OC-12 / STM-4 using one or more 50 MHz channels with one or both polarizations (depending upon the manufacturer's implementation). P-MP systems are currently up to 4 x DS-3's or 5 x 40 Mbps per 50 MHz. This is 180 and 200 Mbps, respectively.

The P-MP hub antennas have sectorized azimuths of 90, 45, and 22.5 degrees with gains of approximately 16, 19, and 23 dBi. Their elevation component has relative to the bore sight about 5 degrees above the horizon and about the same for below. The better P-MP antennas have a Co-secant squared roll off characteristic below the horizon. This implies that using a nominally horizontally elevated antenna for reaching the farther remote stations forces the shorter, higher-elevation links to have minimal margins of about 2-3 dB even when using the +44dBi antennas.

Cell ranges are optimized between frequency re-use, rain zone conditions, and subscriber configuration. Since the deployment of subscriber terminals is an ongoing daily process, this aspect of network deployment must be constantly re-examined to see if adjustments are needed.

III. BWA Operators Maximize Spectrum Reuse by Using Low Power.

Due to the limited amount of spectrum and the very high capacity requirements, it is often necessary for BWA operators to maximally reuse the assigned spectrum. Maximum reuse requires effective intra-cell and inter-cell interference mitigation techniques. The most important of these is to operate as close as practicable to the fade margin needed for 99.999% availability.

Another way BWA operators increase capacity, minimize interference, and maximize performance is to sub-channelize existing 50 MHz channel pairs into either 4 x 12.5 MHz of 5 x 10 MHz sub-channels. This permits deployment with minimal intra-cell interference. The modulation indexes also change from QPSK to 64 QAM (for P-MP systems) and from QPSK to 256 QAM (for P-P systems) with varying occupied bandwidths. For P-MP systems in BWA deployments using TDMA/TDMA it is possible to change the modulation index instantaneously from one frame to the next.

Naturally this changes the capacity of the system. HDFS systems offer guaranteed services that are both fixed and dedicated, such as fiber extensions, video, voice and some private line services. All of these services require 5 x 9's availability to be maintained.

IV. ATPC Enables BWA Networks to Achieve 99.999% Availability with Permanent Fade Margins on the Order of 10 dB.

The use of Automatic Transmit Power Control ("ATPC") allows BWA operators to meet their performance and availability requirements in the most efficient way possible. P-P links in the BWA network operate with minimal margins above the threshold during clear sky conditions, and the RF power is increased to the threshold values required when it rains, up to the calculated 5 x 9's for the rain rate in the zone the equipment is deployed. Therefore, cell radii vary by the rain rate zone, longer in dry climates and shorter in heavy rain zones. The ATPC reaction time is fast, and ATPC can be implemented in relatively small steps.

P-MP systems currently have remote-to-hub ATPC. In the future, it is expected that P-MP systems will have modified software that will enable ATPC in the hub-to-remote direction. This process, however, has yet to be adequately defined in terms of how to detect rain (*i.e.,* reports from multiple remotes) and then how to implement it so that adjacent cell interference in minimized. The process has to be automated and properly correlated with the ATPC in the reverse direction without causing interference problems within the sector.

V. BWA Operators often Have Little Flexibility regarding Deployment Geometries.

The line-of-sight nature of BWA networks limits the deployment of BWA systems significantly. In major urban areas, roof rights are generally expensive and in some cases may be unavailable at any price. In some cases, lack of roof rights requires BWA operators to deploy receivers in an individual office suite (such as through windows or on balconies), rather than in the common space on the roof. Even where roof space is available, key buildings with good line of sight often have other radio/antenna systems on the roof (for

HDFS, television, mobile phones or pagers, etc.). In many cases this limits the ability of BWA operators to move their equipment even a few feet to escape unfavorable geometries.

In dense urban areas, there are times when hubs and/or remotes do not have clear line of sight to the target. In fact, there are links that do not necessarily "connect" to the nearest hub due to line of sight problems. Moreover, there are many situations that create high elevation angles due to distributions of antenna heights that exceed what might be expected from statistical models. For example, just connecting between two buildings "across the street" can create relatively high elevation angles even when the building heights themselves are about even. This is because the antennas are often located in the most cost effective and easily accessible locations (which might be a roof in one case, but a lower floor in another).

Another factor limiting BWA deployment flexibility is that hubs and "Service Nodes" (*i.e.,* hubs with switches) have to be co-located in "carrier hotels" because that is where the landline connectivity with fiber is located. Moreover, these locations tend to need the highest capacity, thus requiring the most frequency reuse.

VI. Protection of FS Systems from Interference Caused by FSS Systems in the Band 37.0 – 40.0 GHz.

The International Telecommunication Union ("ITU") has assumed that the following FS parameters and deployment characteristics, considered to be representative of BWA applications, should be used in the sharing studies between FS and FSS systems in the 37.0 – 40.0 GHz band:

(a) Receiver antenna gain: up to 44 dBi (16 dBi for P-MP hub stations).

(b) Feeder losses: 0 dB.

(c) Receiver Noise Figure: 4 dB.

(d) Elevation angle: 0 to 60 degrees (0 degrees for P-MP hub stations).

These parameters are assumed to be sufficient in calculating interference into FS from FSS applying an I/N methodology. Statistical deployment information on HDFS networks is currently available within the ITU-R for the 37.0 – 40.0 GHz band. These characteristics are documented in Document 4-9S/TEMP/41(Rev.1)-E of the ITU-R.

FIGURE 1

FS AND HDFS Probability Densities of Elevation Angles

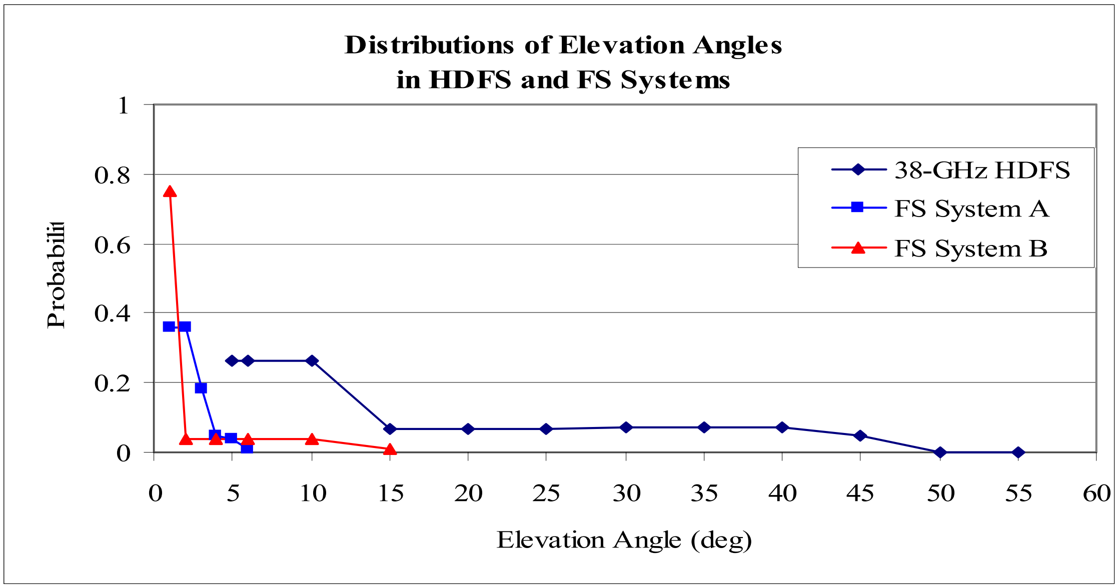
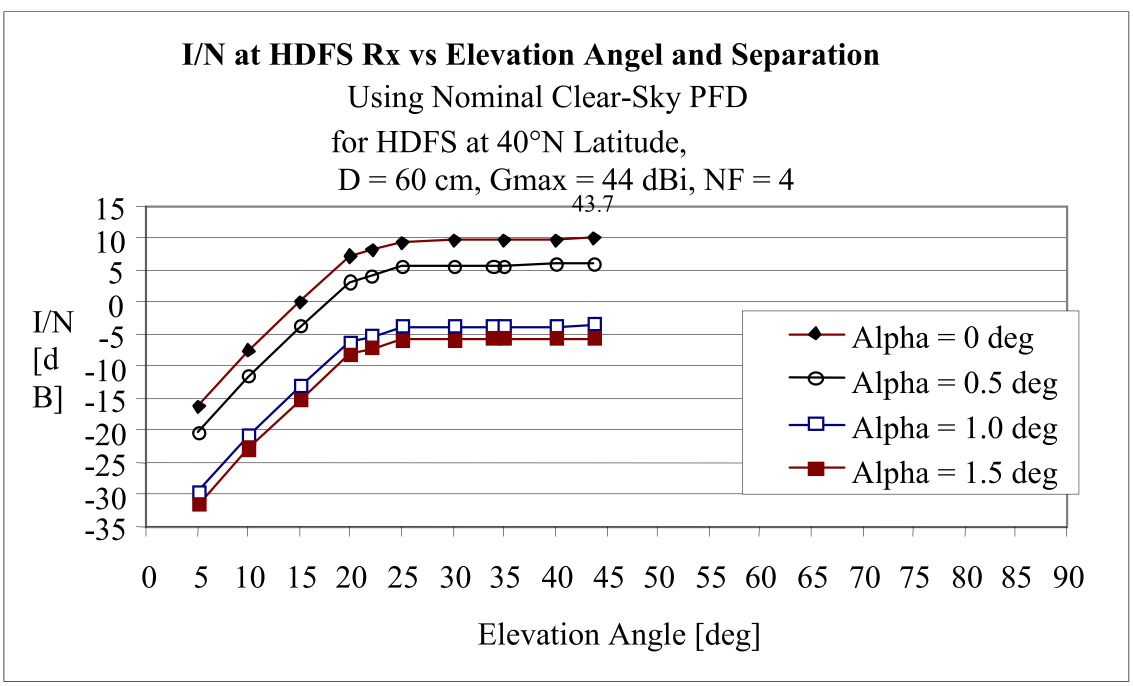


FIGURE 2

I/N at FS Rx vs Elevation Angle and Separation Angle Alpha; GFS = 44 dBi, NF = 4 dB

PFD Mask –139/–119/–117 dB(W/m2) in Any 1 MHz Band



In the band 37.0 – 40.0 GHz, in order to assure that no more than 1% of the deployed links receive excess satellite interference, the nominal clear-sky PFD levels, in any 1 MHz band, at the surface of the Earth from any one GSO satellite should not exceed:

-139 dB(W/m^2)	for $\theta \leq 5°$
$-139 + (4/3)(\theta - 5)$ dB(W/m^2)	for $5° < \theta \leq 20°$
$-119 + 0.4(\theta - 20)$ dB(W/m^2)	for $20° < \theta \leq 25°$
-117 dB(W/m^2)	for $25° < \theta \leq 90°$

Intra-service coordination requirements should also deal with the same type of protection levels.

VII. Information on BWA Deployment Characteristics Currently Available within the ITU-R.

The following references provide useful information on BWA deployment characteristics currently available within the ITU-R:

(a) FS Performance Degradation due to Interference from Other Services:

Document 4-9S/102, pp. 5-6.

(b) BWA Deployment Characteristics in the 38 GHz Band:

Document 4-9S/100, pp. 22-25.

(c) FS Fade Margins in the 38 GHz Band for 99.999% Availability in Different Climatic Zones:

Document 4-9S/98, p. 10.

(d) GSO FSS Interface Criteria:

Document 4-9S/98, pp. 8-13.

(e) Conversion from I/N Data to C/(N+I) Data:

Document 4-9S/58, pp. 8-9.

Attachment-2

Analysis of Uncorrelated Fading Events at 38 GHz, and Impact on HDFS Operation by FSS Power Increase during Fading

0. Introduction

This document analyzes the uncorrelated rain fade events that will impact HDFS deployments that are located within the satellite beam coverage areas of gateway earth stations. It is shown that uncorrelated fading events are a reality even at distances of 8 km, for even a small differetial fade level of 3 dB.

Figure 1 below shows the signal path geometry from the satellite to the gateway earth station and to the HDFS subscriber terminal.

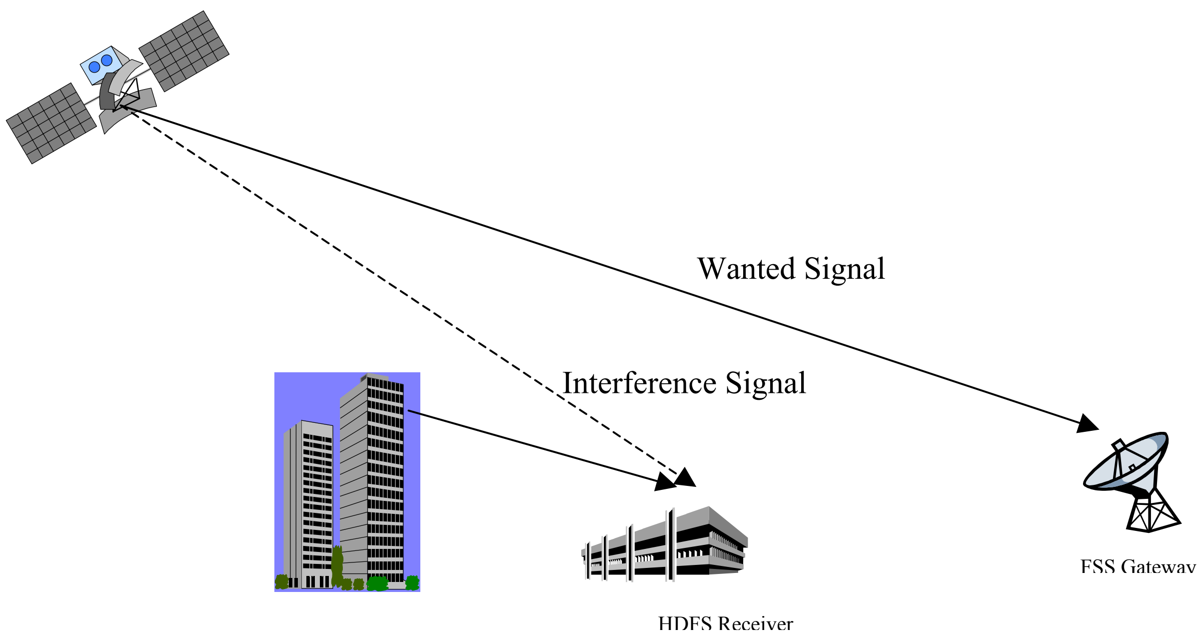


FIGURE 1

FSS/HDFS interference geometry (not to scale)

1. Analysis of Uncorrelated Fading Based on NOAA Weather Radar Observations

The U.S. National Oceanographic and Atmospheric Administration ("NOAA") has implemented multiple sets of the latest generation weather radar called NEXRAD ("NEXt generation RADar"). NEXRAD uses the Doppler effect to monitor the atmosphere, and is now connected to many local TV stations' weather forecasting departments, especially in the Washington, D.C. metropolitan area. Upon observing and analyzing empirical data from NEXRAD and satellite data, the phenomenon described below was observed.

Precipitation, in the form of rain, is non-correlated with respect to location.. The heavier the rain intensity, the less the rain is correlated over a large area. In certain low rain rate areas, it may be observed that the area of coverage appears to have uniform rain distribution (as in gentle drizzle-like rain). However, when it rains with higher intensity the rain cells tend to be much smaller in size. These cells tend to move along with weather fronts, and are typically fast moving.

It is possible to examine NexRad radar data on a regular basis to study rain intensity and distribution patterns in the United States. Some conclusions are:

1. A sample rain accumulation map shown in Figure 2 clearly shows that the heavy rains occur only in very small slivers or pockets and that the lower the rain rate the wider the rain area appears to be.

2. Intense rains typically have a shorter duration in an area of coverage than lighter rain 'cells'.

3. The above conclusions are even more distinct for severe storms and severe weather fronts.

It is interesting to observe and easily deduce the rain rate and phenomena. Rain distribution data seems to follow some common patterns. Namely, for light rain the area of rain is typically larger than for the heavy rains. Moreover, the heavy rains are of much shorter duration. Further, even during very heavy rains, there are areas relatively close by that have either minimal or no rain at all.

It is for these reasons, as seen from the referenced measured data, that the rain (cells) are NOT correlated with respect to location. Thus, satellite footprints (spot beams) of 200+ kilometers radius cannot be adjusted in power flux density (PFD) en masse without affecting the HDFS terrestrial systems that are deployed within the satellite beam coverage area..

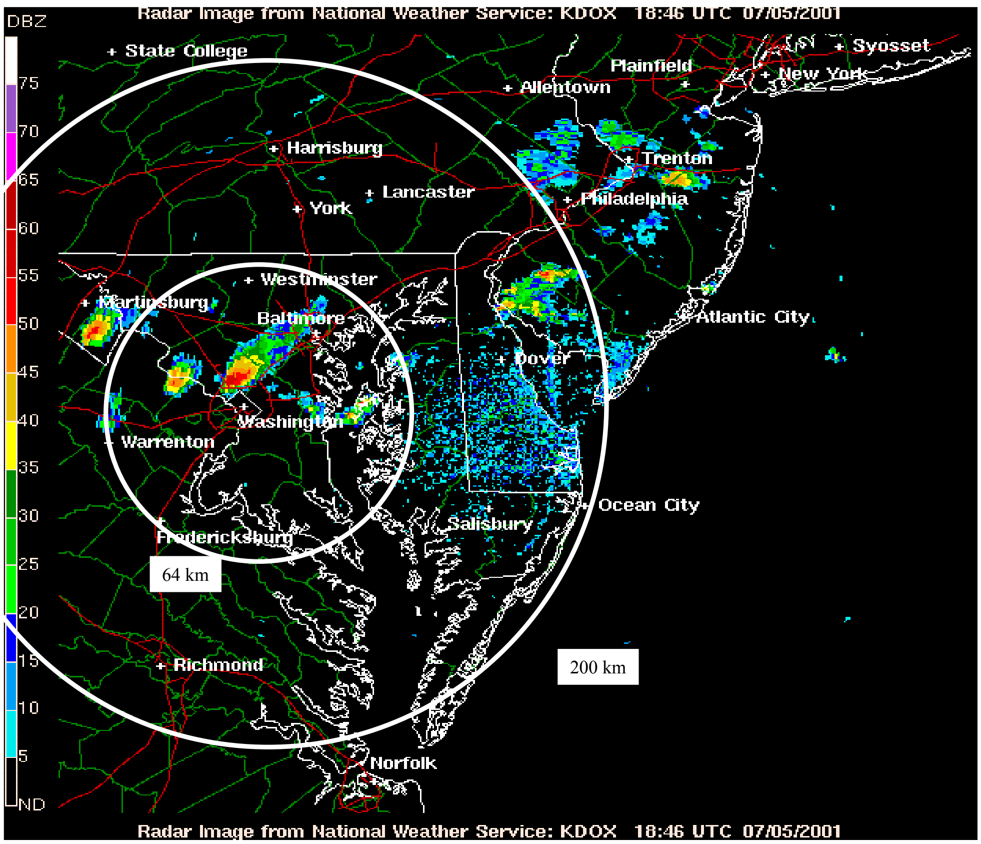
Figure 2 is the rain map of 18:46 UTC 05 Jul 2001 that shows various thunderstorms containing heavy rain and some hail. Two circles are included to show distances. The first is a 64 km circle (40 miles)radius, the distance from Washington DC to Baltimore MD, while the second is a 200 km radius circle that is typical of the minimum satellite spot beam sizes. The latter range reaches Philadelphia PA.

One should note that if there was a satellite earth station located in suburban Maryland (just north of Washington DC), and the satellite were to compensate for the heavy rain cell by increasing its PFD, it would severely affect all the other locations within the 200 km range circle that have little or ZERO rain at the time.

It should be noted that the red, orange, green, blue colors show areas with rain intensity distribution in the descending order. Red color represents very heavy rainfall condition, and blue represents very light rainfall condition. Even within one color, shades of darker to lighter colors show decreasing rain rate conditions.

Figure-2

Rain Map of Eastern United States on 1846UT 05 July 2001



One can study the spatial effects of the FSS and HDFS deployment with Baltimore, Maryland, as the satellite gateway E/S as an example. The following are some sample city distances between Baltimore, Maryland and:

Washington, D.C.	-	56 km.
Philadelphia, PA	-	149 km.
Wilmington, DE	-	105 km.
Frederick, MD	-	58 km.
Rockville, MD	-	53 km.
Alexandria, VA	-	67 km.
Annapolis, MD	-	38 km.
Herndon, VA	-	77 km.

(Note: One can consider a gateway earth station near Wilmington Delaware, and consider the effects on HDFS deployments in the city areas noted above).

Clearly, with these distances and city distributions it may be observed that it is not possible to modify uniformly and dynamically the pfd limits without impacting HDFS systems in the satellite spot beam coverage area. In fact, a rain cell with high precipitation intensity not directly affecting the HDFS links may affect the satellite link and trigger the FSS operator to compensate for its poor link performance.

2. Statistical Interpretation of Rain Cell Structures

Several experts have analyzed the rain cell distribution statistics in various climatic zones. In this section, an analysis is presented of various available data and analyses, in order to develop concise, useful conclusions, concerning the probability and extent of uncorrelated fading. This analysis has been submitted to the 4-9S as a Preliminary Draft New Recommendation to help formulate appropriate understanding of the (un)correlated fading phenomenon.

The information in this section is based on an analysis presented by Goldhirsh (Ref: Julius Goldhirsh, "Two-Dimensional Visualization of Rain Cell Structures", *Radio Science, Vol.35, No.3, PP 713-729, May-June 2000*). The method simulates typical two-dimensional rain rate fields at a particular geographic location, using a point rain rate distribution intrinsic to the region, and an estimate of the number density of rain cells derived from radar measurements. The rain cell data is based on radar measurements performed at Spino d'Adda, near Milan, Italy (Reference: C. Capsoni, et al., "Radar Data Analysis for Propagation Studies", Final Report, ESTEC 4680/81/NL/MS (SC), European Space Agency, Noordwijk, Netherlands, 1983). The database consists of 6215 rain cells. Analytical formulations developed by Capsoni, Awaka, and Goldhirsh, are used to estimate the spatial number density of rain cells conditioned to the cumulative rain rate distribution, and to convert the number density of rain cells into two-dimensional rain rate fields. (Reference: (a) C. Capsoni, et al., "Data and theory for a new model of the horizontal structure of rain cells for propagation applications", Radio Science, 22(3), 395-404, 1987; (b) J. Awaka, " A three-dimensional rain cell model for the study of interference due to hydrometer scattering", J. Commun. Res. Lab., 36(147), 13-44, 1989; (c) J. Goldhirsh, "Two-Dimensional Visualization of Rain Cell Structures", *Radio Science, Vol.35, No.3, PP 713-729, May-June 2000*). The spatial density is calculated for different ITU-R rain zones.

For a rain rate interval of 5 mm/h and area of 10^6 km^2, the number of rain cells results in 684. It is possible to plot the rain cells of different rain rates and resultant number densities within this region. The conclusions are always the same:

- high rain rate cells have smaller radii, and smaller number density
- lower rain rate cells have larger radii and larger number density

A summary of the results is presented in Figures 3 and 4. Figure 3 is a model of the ITU rain zone K region, with X axis showing the rain rate in mm/h, and the Y-axis representing the percentage of the year that the rain rate exceeds the abscissa.

Figure-3
Rain Rate vs Percentage of Year Rain rate Exceeds Abscissa

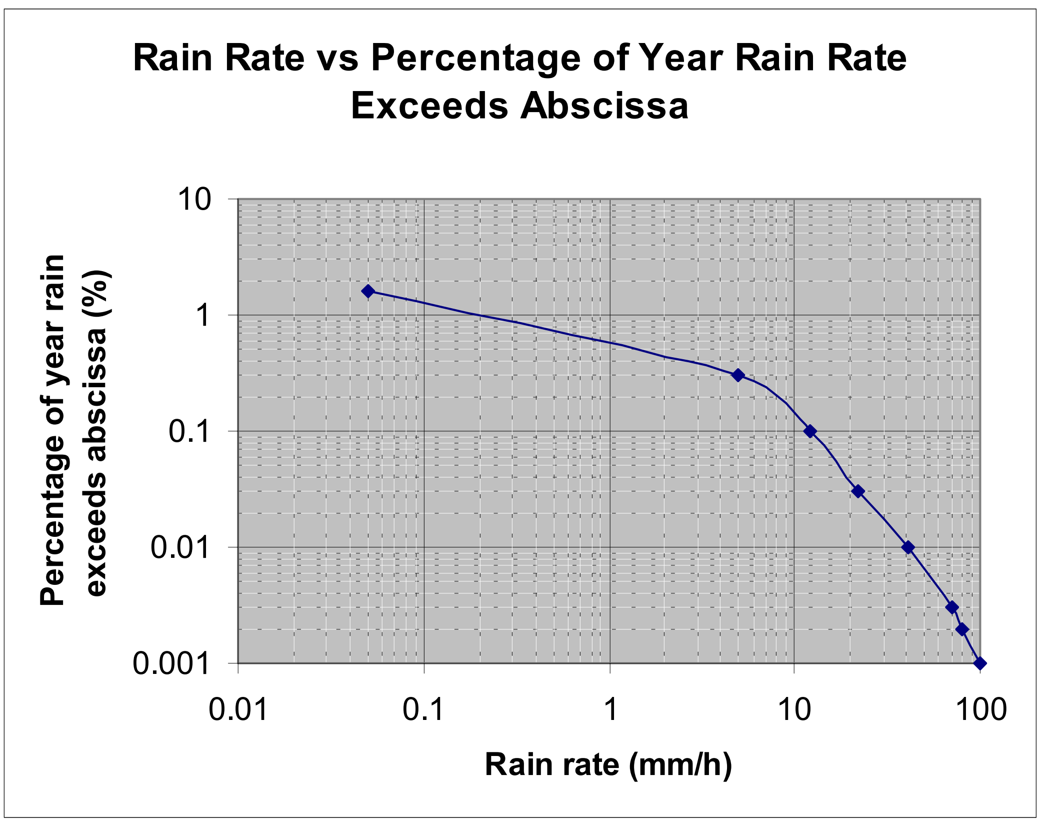
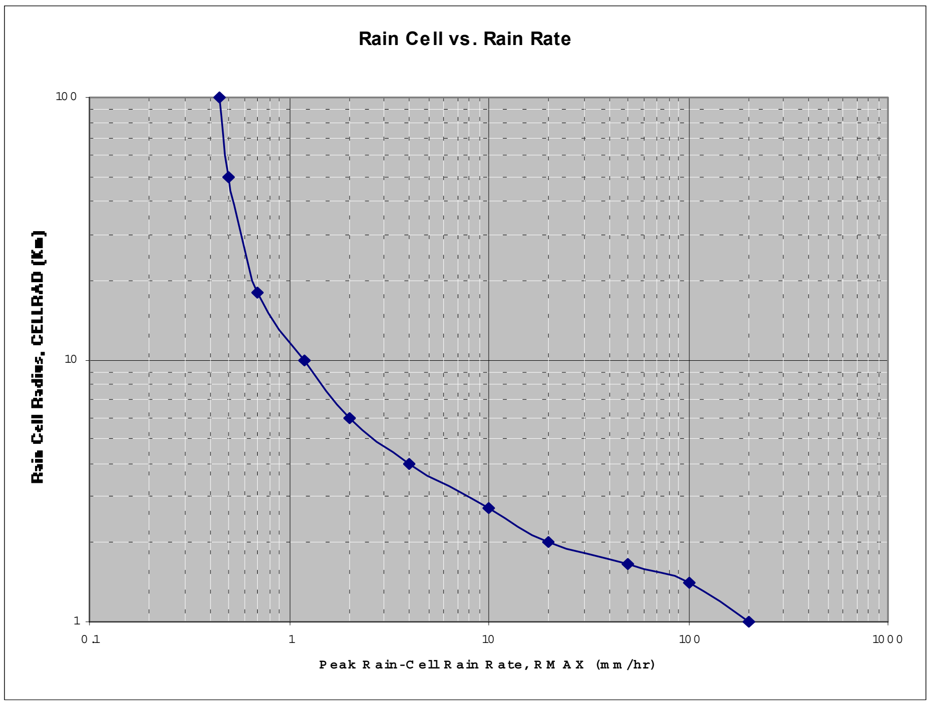


Figure 4 is the depiction of rain rate versus rain cell size based on the analysis described earlier, for Rain Zone K. Similar analyses can be performed for other Rain Zones.

<u>Figure-4</u>
<u>Rain rate versus Rain Cell Size – K Zone</u>



Data presented in Figure 4 fits the observations of storm activity presented earlier. There is inhomogeneous storm activity in a general area that represents the size of a typical V-band satellite beam coverage area, and even over larger areas. Cells representing high rain rates are significantly smaller than cells representing lower rain rates. Further, intense storm fronts representing high rain rates tend to move fast over a region.

3. Conclusions

Precipitation, in the form of rain, is non-correlated with respect to location, and arguments that assume and/or imply that rain is correlated are incorrect. The data presented above indicates that it is impossible for FSS or High Density Fixed Satellite Services ("HDFSS") stations with "spot beams" that have diameters of several hundred kilometers to uniformly adjust their pfd limits <u>without</u> impacting HDFS stations in the same coverage area. Therefore, it may be concluded that frequency sharing in the 37.5 – 40.0 GHz band can only work in very limited, pre-determined areas that protect HDFS but still permit “gateway” type FSS operations.

Under these limited operating conditions, it may be possible for satellite operators who require operation within a certain HDFS license area that is outside these pre-determined areas to “trade off” Decibels of pfd with the HDFS operator, since the increased in satellite output power would result in a potential loss of service for the HDFS operator and a gain for the FSS operator. In this way, it may be possible to pre-determine potential FSS/HDFSS operations in HDFS impacting areas of coverage.

Specifically it is determined:

- In clear-sky conditions:
  - If all GSO FSS satellites operating in the 37.5-40 GHz and 42-42.5 GHz bands operate at the power flux-density values in Table S21-4 minus 12 dB - –139/–119/–117 dB((W/m^2·MHz)) - in normal clear-sky operation, there would be a maximum of 0.95% of HDFS receivers where the aggregate interference-to-noise ratio, I/N, from all GSO FSS transmitters would exceed a –10 dB long term interference criterion. The maximum interference-to-noise ratio, I/N is equal to 9.6 dB.
- In faded conditions:
  - In the case where there is complete correlated fading between the FSS gateway and the HDFS receivers, and the FSS satellite systems increase downlink power flux-density to overcome fading conditions by up to 12 dB, the interference levels at the FS receivers will not increase. The level of interference at the HDFS receivers is reduced if the amount of increase in the downlink power flux-density during fading conditions is less than the rain attenuation on the interfering path, satellite-to-HDFS receivers. However, the percentage of HDFS receivers receiving interference at or more than the I/N=–10 dB remains the same.
  - In the case where HDFS receivers are within the 0 dB to –6 dB contours (within 160 km), there is sufficient evidence that uncorrelated fading dominates the situation. It will be difficult and time consuming to develop the rain fade and rain cell size statistics for every potential location of an FSS gateway. However, further study is required to develop generic data on fade depths, duration’s, and percentage of time of events for typical locations within each ITU-R rain-zone area.
  - In the case where HDFS receivers are between the –6 dB and –12 dB antenna contours (separated by about 160 km from the earth station), the studies show that the interference-to-noise ratio, I/N will increase. Further study is needed to quantify this impact.
  - In the case where HDFS receivers are beyond the –12 dB antenna contour (over about 230 km average from the earth station), the downlink pfd level at the FS receiver is always less than the pfd values in Table S21-4 minus 12 dB due to satellite antenna roll-off, as shown in Figure 1, of Annex 1. Therefore, the FSS

satellite can operate at the pfd limits all of the time and it will not cause increased interference levels at the HDFS receivers. This is the classic case of geographic isolation of gateway location from the HDFS deployment area.